

#52) pH 0.015 mol/L $3.47 \times 10^{-5} = K_a$

$\text{HCNO} + \text{H}_2\text{O} \rightleftharpoons \text{CN}^- + \text{H}_3\text{O}^+$

Acid (aq) base (aq) (aq) (aq)

I 0.015 0 0

C -x +x +x

E 0.015-x x x $\Rightarrow 0.00211$

$\frac{x^2}{0.015-x} = 3.47 \times 10^{-5}$ $0 = x^2 + 3.47 \times 10^{-5}x - 5.205 \times 10^{-6}$

$x = 0.00211$

$\text{pH} = -\log [\text{H}_3\text{O}^+] = 2.68$

$\text{H}_3\text{PO}_4 \rightarrow \text{weak acid}$

$\text{H}_3\text{PO}_4 \xrightarrow{K_{a1}=7.2 \times 10^{-3}} \text{H}_2\text{PO}_4^- \xrightarrow{K_{a2}=6.3 \times 10^{-8}} \text{HPO}_4^{2-} \xrightarrow{K_{a3}=4.2 \times 10^{-13}} \text{PO}_4^{3-}$

ICE

$\text{H}_3\text{PO}_4 + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{H}_2\text{PO}_4^-$ K_{a1}

I 0.015 0 0

C -x +x +x

E 0.015-x x x

$\frac{x^2}{0.015-x} = 7.2 \times 10^{-3}$ $0 = x^2 + 7.2 \times 10^{-3}x - 0.000108$

$x = 0.0052 \text{ mol/L}$

$\text{H}_2\text{PO}_4^- + \text{H}_2\text{O} \rightleftharpoons \text{HPO}_4^{2-} + \text{H}_3\text{O}^+$ K_{a2}

I 0.0052 0 0

C -x +x +x

E 0.0052-x x x

$\frac{x^2}{0.0052-x} = 6.3 \times 10^{-8}$ $0 = x^2 + 6.3 \times 10^{-8}x - 3.276 \times 10^{-8}$

$x = 0.000023$

Molecular base: (no OH^-)

↳ "nitrogen" bases or other bases that involve covalent bonds.

Ex: NH_3 \rightarrow PH_3

- Lone pair on central atom that can accept H^+ .

$\text{Base} + \text{H}_2\text{O} \rightleftharpoons \text{OH}^- + \text{HB}^+$ $K_b = K_b$

base dissociation constant

ask for pH

1. find $[\text{OH}^-]$ - ICE chart

2. find $\text{pOH} = -\log [\text{OH}^-]$

3. find $\text{pH} = 14 - \text{pOH}$

Ex: Determine the K_b of pyridine $\text{C}_5\text{H}_5\text{N}$ if 16g/L has a pH of 9.23.

hint

$[\text{H}_3\text{O}^+] = [\text{OH}^-]$ neutral

$[\text{H}_3\text{O}^+] > [\text{OH}^-]$ acid

$[\text{H}_3\text{O}^+] < [\text{OH}^-]$ base

$\text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{OH}^-$

pH scale

Base equilibrium:

$\text{C}_5\text{H}_5\text{N} + \text{H}_2\text{O} \rightleftharpoons \text{C}_5\text{H}_5\text{NH}^+ + \text{OH}^-$

I 0.202 0 0

C -x +x +x

E 0.202-x x x

$K_b = \frac{[\text{C}_5\text{H}_5\text{NH}^+][\text{OH}^-]}{[\text{C}_5\text{H}_5\text{N}]}$

$1.4 \times 10^{-2} = \frac{x^2}{0.202-x}$

$x = 0.053$

$\text{pOH} = 1.28$

$\text{pH} = 12.72$

#32) methylamine CH_3NH_2 0.25 mol/L

$\text{CH}_3\text{NH}_2 + \text{H}_2\text{O} \rightleftharpoons \text{CH}_3\text{NH}_3^+ + \text{OH}^-$

I 0.25 0 0

C -x +x +x

E 0.25-x x x

$K_b = 4.4 \times 10^{-4}$

$\frac{x^2}{0.25-x} = 4.4 \times 10^{-4}$ $0 = x^2 + 4.4 \times 10^{-4}x - 0.00011$

$x = 0.011$

$\text{pOH} = 1.96$

$\text{pH} = 12.04$

$[\text{OH}^-] = 1.09 \times 10^{-2} \text{ mol/L}$